SUBMUCOSAL DISSECTION OF THE RETROPHARYNGEAL SPACE DURING NASAL INTUBATION

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Various complications have been reported with nasal endotracheal intubation including bleeding, epistaxis, bacteremia, damage to intranasal structures, and even intracranial penetration. We present two cases that required general anesthesia for dental surgery. Submucosal dissection of the retropharyngeal tissues occurred during attempted nasal endotracheal intubation. Previous reports of this complication are reviewed, treatment strategies presented, and potential maneuvers to prevent this complication suggested.

Introduction

Endotracheal intubation via the nasal route is performed in various clinical scenarios including intraoperative care of patients undergoing oromaxillary or dental surgery. Although generally safe, nasal endotracheal intubation has a greater potential for trauma to the mucosa of the nasopharynx than does routine oral endotracheal intubation. Various complications have been reported including bleeding, epistaxis, bacteremia, damage to intranasal structures, and even intracranial penetration[1,2]. We present a pediatric patient presenting for dental surgery in whom submucosal dissection of the retropharyngeal tissues occurred during attempted nasal endotracheal intubation. Previous reports of this complication are reviewed, treatment strategies presented, and potential maneuvers to prevent this complication suggested.

Case Report

Institutional Review Board approval is not required at Nationwide Children's Hospital (Columbus, Ohio) for the presentation of case reports involving two patients.

Patient #1: The patient was a 4-year-old, 20.5 kg girl who presented for oral rehabilitation under general anesthesia for the treatment of dental caries. Her past medical history was significant for recurrent acute otitis media. Her past surgical history included adenotonsillectomy for tonsillar hypertrophy. There were no associated co-morbid conditions. The patient was not on any home medications. Preoperative physical examination revealed a well-appearing girl in no acute distress and a normal systemic examination with dental caries in the oral cavity. On the day of surgery, the patient was held *nil per os* for 6 hours. She was transported to the operating room and routine

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American Society of Anesthesiologists' monitors were applied. Anesthesia was induced with the inhalation of sevoflurane in nitrous oxide and oxygen. After the induction of anesthesia, a 22 gauge peripheral intravenous catheter was placed in the left hand and propofol was administered to deepen the level of anesthesia. Bag-valve-mask ventilation was provided without difficulty. Following lubrication of the right nare, a 4.5 mm cuffed endotracheal tube (ETT) was passed through the nare in preparation of nasal endotracheal intubation. Direct laryngoscopy was performed and blood was noticed in the supraglottic area and the oropharynx. The patient's oropharynx was suctioned and a submucosal bulging was noted in the retropharyngeal space. Pediatric otolaryngology was consulted as it was thought that the nasal ETT had caused a blind submucosal tract. With the nasal ETT in place, an oral 4.5 mm cuffed ETT was placed into the trachea without difficulty under direct vision using a Miller 2 blade. The patient was kept in the supine position and anesthesia was maintained with sevoflurane in air and oxygen. The pediatric otolaryngologist noted a submucosal dissection of the retropharyngeal space. Based on their recommendation, the ETT was removed and prophylactic antibiotics (clindamycin) administered. The dental procedure was then completed without problems. During the procedure, the patient experienced an episode of bronchospasm and mild hypotension which was attributed to an anaphylactoid reaction to the clindamycin infusion. The bronchospasm was treated with albuterol administered via the ETT using a metered dose inhaler and a single intravenous dose of epinephrine (30 µg). Additional medications during the procedure included dexamethasone (4 mg), ondansetron (2 mg), and fentanyl (35 µg). Following completion of the procedure, the patient's trachea was extubated when awake. She was transferred to the Post Anesthesia Care Unit (PACU) in a stable condition. The patient was kept for observation in the general pediatric overnight. Postoperative pain control was provided by intermittent, as needed doses of oral ibuprofen. A 7 day course of oral antibiotics (amoxcillin-clavulanate) was completed. Her postoperative period was uneventful and she was discharged the next day. No complications related to the submucosal dissection were noted.

Patient #2: The patient was a 6-year-old, 22 kg boy who presented for oral rehabilitation under general anesthesia for the treatment of dental caries at the ambulatory surgery center. There was no past surgical or medical history. There were no associated co-morbid conditions. The patient was not on any home medications. Preoperative physical examination revealed a well-appearing boy in no acute distress and a normal systemic examination with dental caries in the oral cavity. On the day of surgery, the patient was held *nil per os* for 6 hours. He was transported to the operating room and routine American Society of Anesthesiologists' monitors were applied. Anesthesia was induced with sevoflurane in oxygen and nitrous oxide. After the induction of general anesthesia, a 22 gauge peripheral intravenous cannula was inserted. After achieving topical vasoconstriction with 4 drops of 0.05% oxymetazoline, a softened and lubricated 5.0 mm cuffed nasal RAE ETT was inserted into the right nostril with minimal resistance. Under direct laryngoscopy, the ETT was advanced further; however, the tip of the ETT was not visualized in the oropharynx. The ETT was noticed advancing under the mucosa of the right posterior pharyngeal wall. The procedure was abandoned, the nasal ETT was left undisturbed and an oral ETT was placed without difficulty. A pediatric otolaryngology consultation was obtained. The nasal ETT was removed under direct visualization of the ENT surgeon; however, a posterior pharyngeal hematoma was noted and a CT scan of the neck was recommended. The dental procedure was cancelled and the subsequent CT scan revealed no vascular injury or posterior pharyngeal hematoma. The patient was admitted for overnight observation. Antibiotic prophylaxis was provided by oral Augmentin (amoxicillin-clavulanate potassium). He was discharged home the next day with instructions to follow up in the otorhinolaryngology clinic in 6 weeks.

Discussion

Although required to facilitate various oromaxillary and dental surgical procedures, there is a higher incidence of adverse events related to nasotracheal intubation when compared to standard oral endotracheal intubation. A complication rate of 3% to 16% has reported with nasotracheal intubation

with many being noted during prolonged attempts due to a higher failure rate when compared with oral intubation. One way of classifying involves separation into adverse events related to: 1) stimulation of the sympathetic nervous system and physiological changes related to pain; 2) occlusive problems related to the presence of an endotracheal tube in the nasaopharynx; and 3) traumatic problems. Physiologic changes related to pain and stimulation of the sympathetic nervous system includes hypertension, tachycardia, arrhythmias, and increased intracranial pressure. Occlusive problems include from long term placement of a nasal endotracheal tube and can result in otitis media secondary to the obstruction of nasal and pharyngeal ostiae and maxillary sinusitis[4,5]. Problems from direct trauma during passage of the endotracheal tube through the nasopharynx include bleeding, damage to the nasal turbinates, bacteremia, dislodgement of adenoids, or even rare reports of penetration of the cranial vault with intracranial placement of the endotracheal tube[6-13] Epistaxis is the most common of the traumatic complications with a reported incidence varying from 10 to 80% based on the technique and definitions used. Posterior epistaxis can result in a significant hemorrhage while anterior epistaxis generally resolves on its own.

As noted in our two patients, another albeit rare yet potential complication of nasal endotracheal intubation is the submucosal passage of the ETT. The first report in the literature regarding this complication appeared in 1975 with the description of 3 cases are of retropharyngeal dissection as a complication of nasal endotracheal intubation[14]. In all three of the cases, after introduction of the ETT through the nare, the tip could not be visualized in the oropharynx during direct laryngoscopy. Palpation revealed that the ETT was in the submucosal plane. As noted from the patients reported herein, the initial report from 1975, and others from the literature, retropharyngeal dissection may occur from trauma to the pharyngeal wall during nasal placement of an ETT (Table 1)[15-20]. Fortunately, this complication is generally benign if recognized early. The literature has reported no long term complications related to the creation of the false passage and no reports of significant bleeding although localized hematomas as noted in our second patient have been reported in the literature. However, there remains a risk of morbidity and even mortality if positive pressure is administered as subcutaneous emphysema, pneumothorax, and pneumomediastinum can develop.

This complication can potentially be prevented or its incidence at least decreased by a systematic approach with appropriate preparation of the nare and the ETT prior to its passage through the nostril. Careful selection of the more patent nare can also be helpful. Comparing the airflow or probing with a swab used to apply a topical vasoconstrictor can help in selecting the most patent naris. Alternatively, the nare can be progressively opened by the passage of progressing larger lubricated nasal trumpets. As the ETT is advanced, excessive force should be avoided and the ETT should never be advanced against resistance. The ETT should be advanced in a plane that is parallel to the floor of the hard palate, generally perpendicular to the bed when the patient is supine. Additionally, trauma can be limited by the use of lubrication of the ETT, the application of topical vasoconstrictors, and thermosoftening or warming of ETT[1,21-24]. Although various topical vasoconstrictors such as epinephrine, phenylephrine, oxymetazoline, and cocaine have been shown to effective, they may be associated with life-threatening cardiovascular complications including cardiac arrhythmias as well as systemic and pulmonary hypertension[25-30].

The bevel of an ETT is left-facing which may favor its advancement through the left nare along the nasal septum with the bevel facing outward thereby potentially limiting trauma. However, a recent study demonstrated no advantage to either the left or right nare regarding success rates and untoward events[31]. Kihara et al compared a silicone-based wire-reinforced ETT with a hemispherical bevel is superior to a polyvinyl chloride (PVC)-based pre-curved tube with a conventional diagonal bevel for nasotracheal intubation in adults[22]. Although the pharyngeal and tracheal placement phases of nasotracheal intubation required fewer attempts with the silicone ETT than the PVC ETT, the glottic placement phase required more attempts. No difference in intubation times was noted between the two groups. The frequency (32% versus 80%; $P<0.0001$) and severity of epistaxis were less with the silicone ETT. In a similar study to assess the potential impact of ETT design on trauma

Table 1
Previous reports of submucosal dissection during nasotracheal intubation

Authors and reference	Patient demographics	Intraoperative findings and management
Peña MT et al[15]	A 6-year-old girl for elective surgery.	Positive pressure ventilation after attempted nasotracheal intubation resulted in subcutaneous emphysema. Procedure was deferred and clindamycin administered for antibiotic prophylaxis. Computed tomography imaging demonstrated air within retropharyngeal tissues and along the right carotid artery. No long term sequelae.
	8-year-old boy with Noonan syndrome with respiratory failure.	Four centimeter laceration of the posterior trachea, developing pneumomediastinum after nasotracheal intubation.
Ghaffari S et al[16]	7-year-old girl for tonsillectomy.	Uncuffed nasal tube was inserted by the surgeon through the right nare. No problem was noted and endotracheal intubation was completed. During the procedure, it was noted that the nasotracheal tube pierced the posterior pharyngeal mucosa and then re-entered oropharynx.
Bozdogan N et al[17]	67-year-old man for uvulopalatopharyngoplasty.	During the surgery, it was noted that the nasotracheal tube had penetrated the oropharyngeal mucosa in the retropharyngeal space and then re-entered the oropharynx. The ETT was left in place during surgery to prevent bleeding. After surgery, a vertical incision was made through the mucosa surrounding the tube from the inferior pouch up to the nasopharynx to explore the site.
Krebs MJ et al[18]	A 54-year-old, 95-kg woman for excision of a mandibular ossifying fibroma.	After passage of the ETT through the nare, direct laryngoscopy could not identify the tip of the nasotracheal tube in the oropharynx. A longitudinal submucosal bulge was noted in the posterolateral wall of the pharynx. Digital palpation confirmed that the tip of the ETT had made a false passage into the nasopharyngeal submucosa. The nasotracheal tube was removed and a standard orotracheal ETT was placed without difficulty. The right-sided nasopharyngeal cavity was packed with sterile gauze for prophylactic tamponade. Clindamycin was administered for antibiotic prophylaxis.
Chait DH et al[19]	33-year-old woman.	Retropharyngeal dissection during nasotracheal intubation was immediately noted during direct laryngoscopy and digital palpation. There was brief epistaxis, which spontaneously stopped. Penicillin was administered for antibiotic prophylaxis.
Landess WW.[20]	90-year-old woman for repair of femoral fracture.	Nasotracheal intubation attempted when oral intubation and direct laryngoscopy failed. Resistance was noted with passage of the nasotracheal tube.

during nasotracheal intubation, although thermos-softening effectively reduced the severity of epistaxis for both types of conventional types of ETT, there was no difference in the severity of epistaxis and the incidence of nasal injury and pain between the Magill-tipped, non-thermo-softened ETT and Murphy-tipped, thermos-softened ETT[32].

What is generally accepted is that gentle warming of the ETT reduces the incidence and severity of trauma. The technique is commonly referred to as "thermosoftening"[23,24]. However, excessive heating can make the ETT too soft thereby making successful passage of the ETT and endotracheal intubation more difficult. In our practice, the ETT is placed in sterile normal saline which is kept in a warmer with the temperature carefully controlled to prevent over-heating.

In a prospective comparison, it has been

demonstrated that trauma can be reduced by placing a red rubber catheter over the ETT prior to advancing it through the nasal passage[33]. The tip of the ETT is passed into the flange of the red rubber catheter and the taper end is then advanced into the nasal passage. Direct laryngoscopy is performed and the red rubber catheter is removed as the ETT is advanced once it is visualized in the oropharynx. Although the intubation process took longer with the red-rubber catheter technique, there was less trauma and less bleeding. Similar findings were reported by Enk et al[21]. A finger cot has also been used to protect the advancing end of the ETT and thereby limit trauma; however, these smaller devices can potentially be lost in the nasopharynx or airway and are therefore not recommended[34]. Alternatively, other items such as suction catheters, gum elastic bougies or nasogastric tubes can be passed through the nasal passage to act as a guide for the ETT[35-38].

The suggestions made above for the atraumatic passage of a nasal endotracheal tube intranasally can be divided into 3 categories:

Never advance the ETT with against resistance. The ETT should be passed in a plane that is parallel to the hard palate. As there has been an increased use of cuffed ETTs in infants and children, this allows the use of a smaller ETT which may pass more easily through the nasal passages and limit the incidence of trauma. .The cuff can then be inflated to seal the airway

The nasopharynx should be prepared prior to the procedure with a vasoconstrictor. Although there may be significant hemodynamic effects with excessive dosing, the topical application of a vasoconstrictor such as oxymetazoline is suggested. This should be done with careful attention to recent dosing and administration recommendations[29,30]. The nasal passage can also be progressively dilated by the passage of progressively .larger, well-lubricated nasal trumpets

The distal end of the endotracheal tube can be covered in order to minimize trauma from the leading edge the ETT with a red-rubber catheter or advanced over a suction catheter or nasogastric tube that has been placed .through the nasal passage

Should submucosal dissection occur, we would recommend the following treatment algorithm:

1. Leave the ETT in place and secure the airway .with oral endotracheal intubation if possible

Obtain otolaryngology consultation for direct inspec- .tion of the site

While there is no evidence-based medicine to demonstrate efficacy, the majority of reports and the patients reported herein were treated with antibiotics (intravenous and then oral) with either clindamycin or penicillin to provide appropriate coverage for oral flora in- .cluding anaerobes

Never attempt positive pressure ventilation unless the ETT is in the trachea. An unnoticed retropharyngeal dissection can worsen with an attempt to ventilate with the tube or any additional force resulting pneumome- .diastinum or pneumothorax

If there is a concern for hematoma formation or dam- .age to vital structures, a CT scan should be obtained

Postoperative inpatient observation is suggested as late bleeding with hematoma formation may compromise .the airway

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